INNOVATIVE MICROWAVE-ASSISTED DRYING PROCESS FOR SEA BUCKTHORN SEEDS IN A SUSPENED LAYER

Tatiana BALAN[1*], ORCID: 0000-0002-8897-105X
Igor GÎDEI[1], ORCID: 0000-0001-6188-942X
Victor POPESCU[2], ORCID: 0000-0002-4634-2255
Natalia ȚISLINSCAIA[1], ORCID: 0000-0003-3126-5792
Vitali VIȘANU[1], ORCID: 0000-0002-2273-342X
Mihail BALAN[1], ORCID: 0000-0002-7788-345X
Mihail MELENCIUC[1], ORCID: 0000-0001-6575-8814

[1] *Department of Mechanical Engineering, Technical University of Moldova, Chisinau, Republic of Moldova*
[2] *Department of Electrical Engineering, Technical University of Moldova, Chisinau, Republic of Moldova*

*Corresponding author: Tatiana Balan, tatiana.balan@doctorat.utm.md

Introduction. Sea buckthorn seeds contain highly valuable, thermolabile bioactive oils that degrade rapidly under prolonged conventional thermal treatments. Standard stationary bed drying techniques often cause non-uniform moisture removal, resulting in localized heat damage and reduced nutritional quality. To address these industrial challenges, this research evaluates a novel processing technology combining aerodynamic fluidization with electromagnetic volumetric heating to achieve high uniformity, minimize operational duration, and preserve structural integrity.

Material and Methods. The experimental methodology utilizes a vertically oriented square-section tube configured to establish a stable suspended layer of oilseed matrices. Aerodynamic fluidization was initiated by deploying an air stream calibrated to a constant velocity of 9.6 m/s, yielding a volumetric flow rate of 360 m³/h. Volumetric heating was introduced via an integrated ultra-high frequency system. The multi-stage dehydration sequence was systematically monitored over discrete temporal phases to track mass reduction, moisture migration, and aerodynamic sorting behavior.

Results and Discussion. The combined dehydration process operates through three distinct, highly controlled functional stages. During Stage I, raw sea buckthorn seeds are introduced into the vertical square column, where the aerodynamic parameters successfully establish a continuous fluidized layer. In Stage II, the specialized microwave generator is activated at an operational power output of 350 W operating at a frequency of 2460 MHz for a duration of 140 minutes, which drastically accelerates internal moisture diffusion toward the outer boundary layers. Finally, Stage III governs automatic, density-driven material segregation. As moisture evaporates, the seed mass changes dynamically, causing automated separation based on specific gravity. Individual matrices with the lowest moisture and mass separate out first, followed sequentially by intermediate fractions. The final fraction, consisting of seeds with higher initial mass and moisture content, reaches terminal velocity and separates out after approximately 190 minutes. This multi-phase interaction guarantees exceptional drying homogeneity while significantly reducing the total thermal exposure time compared to conventional systems.

Conclusions. The integration of a combined aerodynamic suspended layer and electromagnetic fields solves the technical challenges of oilseed processing. This combined technology optimizes overall energy efficiency, ensures precision process control, and prevents thermal degradation. The system offers a promising, highly scalable engineering solution for modern high-efficiency processing applications in the functional food sector.

Keywords: *aerodynamic fluidization, automatic segregation, biomaterial quality, electromagnetic volumetric heating, oilseed matrices*

Acknowledgments. The results described were obtained through research conducted within the project: 020405 “Optimization of food processing technologies in the context of the circular bioeconomy and climate change”.